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## Morning

Think that you are on top of the Campanile just before sunrise.  
Feel the wind, the humidity, the heat. Or cold.  
Imagine that the sun did not rise and make music to take its place.

3 minutes, daily, at sunrise.

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“Morning” is my question and the following installation/performance is one answer, made with an arduino kit and sensors.<sup>1</sup>

A good carillonneur is aware of time and place and especially her audience. Carillonneurs are not musicians trapped in a tower, cut off from society. Though anonymous, carillonneurs must be sensitive to the public’s culture and desires, as represented by the sensed inputs. In this installation, the immediate surroundings (temperature, brightness, heart rate etc.) are transformed into a unique signature for the sunrise, played as the sun rises.

A system using the inputs below creates output: two thick chords (or a series of notes that make sense together) that are improvised upon using the outputted tempo and mood, for 3 minutes.

This system is dynamic. A few minutes before sunrise and the time of the performance, the performer generates the current day’s chord, mood, and tempo according to the current temperature, brightness, heart rate, etc. But the performed piece uses not only the current day’s outputs, but also the previous day’s, as a transition from yesterday to today. So if yesterday’s chord is  $C^{7\flat 9\flat 5}$ , and today’s is

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<sup>1</sup> The kit and sensors are available at <http://arduino.cc/en/Main/Products> and <http://moderndevice.com/product-category/sensors/>.

<sup>2</sup> The normalization process will use the mean + two standard deviations as the max (which corresponds to 16),

A<sup>7</sup>sus<sup>4</sup>, the performer will start her improvisation with C<sup>7</sup> <sup>b</sup>9 <sup>b</sup>5 and end with A<sup>7</sup>sus<sup>4</sup>, played using the outputted tempo and mood.

The normalization process of the inputs in order to correspond to the outputs gives the system a memory, which should begin on the day of the Centennial.

*INPUTS:*

*T = Temperature*

*B = Brightness*

*P = Heart Rate of Performer*

*W = Wind speed*

*H = Humidity*

*R = Red component of color sensor*

*G = Green component of color sensor*

*B = Blue component of color sensor*

*S<sub>X</sub> = Standard deviation of input X*

*OUTPUTS:*

*1. Tempo*

*2. Mood (Gradient)*

*3. Chord*

The heart rate of the performer (beats per minute) and the wind speed (miles per hour) determine the tempo of the play. The sum of these two, which favors the heart rate of the performer, is then normalized to a number between 1 and 16, which then corresponds to a tempo.<sup>2</sup>

The overall average color sensed by the 16 photodiodes can be placed on a spectrum, where a range of wavelength would correspond to a particular mood. Appendix A puts forth an example range.

Temperature, humidity, and brightness (with normalization) determine the chord generated. Chords are lined up in order (keys with few accidentals to keys with more accidentals) from Major Basic Chord to Major More Complicated Chord (such as adding a seventh, sixth, fourth, etc.) to Minor More Complicated Chord to Minor Basic Chord. So on a hot, dry, and bright day, the chord generated leans towards a Major Basic Chord, and on a cold, humid, dark day, the chord generated leans towards a Minor Basic Chord.

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<sup>2</sup> The normalization process will use the mean + two standard deviations as the max (which corresponds to 16), and the mean - two standard deviations as the min (which corresponds to 0), to offset the impact of outliers, such as a day with hurricane wind speeds, since the data collection for normalization begins at the day of the Centennial.

## Appendix A

<i>Tempo</i>	<i>Mood</i>
<i>Slower</i>	<i>[Color Spectrum from Red (~650 nm) to Green (~550 nm) to Blue (~450 nm)]</i>
1. <i>Largo</i>	1. <i>Con fuoco</i>
2. <i>Larghetto</i>	2. <i>Furioso</i>
3. <i>Lento</i>	3. <i>Animato</i>
4. <i>Largamente</i>	4. <i>Bruscamente</i>
5. <i>Adagio</i>	5. <i>Agitato</i>
6. <i>Adagietto</i>	6. <i>Brillante</i>
7. <i>Sostenuto</i>	7. <i>Con brio</i>
8. <i>Andante</i>	8. <i>Vivace</i>
9. <i>Moderato</i>	9. <i>Slancio</i>
10. <i>Alla marcia</i>	10. <i>Scherzando</i>
11. <i>Allegretto</i>	11. <i>Con spirito</i>
12. <i>Allegro</i>	12. <i>Risolto</i>
13. <i>Affretando</i>	13. <i>Maestoso</i>
14. <i>Mosso</i>	14. <i>Colossale</i>
15. <i>Presto</i>	15. <i>Con moto</i>
16. <i>Prestissimo</i>	16. <i>Comodo</i>
<i>Faster</i>	17. <i>Espressivo</i>
	18. <i>Cantabile</i>
	19. <i>Con amore</i>
	20. <i>Affettuoso</i>
	21. <i>Misterioso</i>
	22. <i>Lontano</i>
	23. <i>Semplicemente</i>
	24. <i>Sotto</i>
	25. <i>Mesto</i>
	26. <i>Lacrimoso</i>
	27. <i>Doloroso</i>

## Artist Bio

I am interested in the intersection of mathematics, music, and the artist's hand. This exploration is infinite, with innumerable physical and imaginary representations, but so far has manifested in a series of music compositions called "Circle in Square" that use a simple algorithm to choose notes at the intersection of a circle inscribed in a square, and long scrolls of calligraphic scores that were created from the memory of specific pieces of music.

I graduated from Yale University in mathematics and art in 2012, and from the Royal Carillon School in Mechelen, Belgium in 2013. I spent last year working in economic consulting, giving carillon recitals, and performing short theatre pieces on randomness and music, and in 2015, I will start an MFA in painting at Hunter College in New York City. In the summer, I teach various 2D arts at the Sitka Fine Arts Camp in Alaska.

## Qualifications

At Yale, I participated in a six-week workshop on Arduino. I've programmed in various languages, including SAS, java, and Python.

The Arteles Residency in Finland has accepted me for the month of September, when I plan to work more on this idea of transforming a physical experience of place into one on bells.